STUDY GUIDE

TRICKLING FILTERS AND RBC'S

INTRODUCTION AND ADVANCED

SUBCLASS B

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PREFACE

This operator's study guide represents the results of an ambitious program. Operators of wastewater facilities, regulators, educators and local officials, jointly prepared the objectives and exam questions for the Introduction to Trickling Filtration and RBC's Exam.

The objectives in this study guide have been organized into four modules: (A) Principles, Structure and Function; (B) Operation and Maintenance; (C) Monitoring and Troubleshooting; and, (D) Safety and Calculations. The objectives are organized to correspond to the major concepts in each module.

New exam questions have been written to correspond to the concepts included in this study guide.

HOW TO USE THESE OBJECTIVES WITH REFERENCES

In preparation for the Introduction to Trickling Filtration and Rotating Biological Contactors (RBC's), the operator should:

1. Read all the objectives and write down the answers to the objectives that readily come to mind.

2. Use the resources at the end of the objectives to look-up those answers you are not sure of.

3. Write down the answers found in the resources to those objectives you could not answer from memory.

4. Review all answered objectives until you can answer each from memory.

IT IS ADVISABLE THAT THE OPERATOR ATTEND SOME FORM OF FORMAL TRAINING IN THIS PROCESS BEFORE ATTEMPTING THE CERTIFICATION EXAM.

Choosing A Test Date

Before you choose a test date, consider the training opportunities available in your area. A listing of training opportunities and exam dates can be found in the annual DNR " Certified Operator," or by contacting DNR District operator certification coordinator.

INTRODUCTION

INTRODUCTION
TO
TRICKLING FILTERS AND ROTATING BIOLOGICAL CONTACTORS

MODULE A: PRINCIPLES, STRUCTURE AND FUNCTION

CONCEPT: PRINCIPLES OF TRICKLING FILTERS AND RBC'S

1. Describe the wastewater treatment process of Trickling Filters and Rotating Biological Contactors (RBC'S).

2. Discuss the types of waste treated by a Trickling Filter and an RBC.

3. Explain the purposes served by the media in a Trickling Filter and on an RBC.

4. Describe the effect of algae growth on the media of a Trickling Filter and an RBC.

5. List the reasons why good primary treatment is needed for effective Trickling Filter and RBC operation.

CONCEPT: STRUCTURE AND FUNCTION

6. Describe the containment and types of media used in Trickling Filters.

7. Describe the type of media and stages used on an RBC.

8. Discuss the structure and function of the following Trickling Filter mechanisms:

A. Underdrains.
B. Reactionary Distributors.
C. Distributor End Gates.
D. Speed Retarder Nozzles (Orifices).
E. Turnbuckles and Stay Rods (Guy Wires).
F. Inlet and Outlet Valves.

9. Discuss the structure and function of the following RBC mechanisms:

A. Mechanical Drive.
B. Air Drive.
C. Load Cells.

10. Describe the purposes and types of covers used on for Trickling Filters and RBC's.

11. Explain the function secondary clarifiers have in a Trickling Filter or RBC plant.

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MODULE B: OPERATION AND MAINTENANCE

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CONCEPT: OPERATION

12. List the initial environmental and operational characteristics necessary for proper operation of an RBC unit.

13. Describe the appearance of biomass growth under the media layers of a Trickling Filter and the stages of an RBC.

14. List what an operator should look for when evaluating the condition of the biomass growth on Trickling Filter and RBC media.

15. Explain the possible affects on the operation of uneven flow distribution over the media of a Trickling Filter.

16. Explain the purpose of media ventilation in the operation of a Trickling Filter and an RBC.

17. Describe why dissolved oxygen levels in tanks below the discs should be checked for proper RBC plant operation.

18. List the purposes and schemes used for recirculation in a Trickling Filter or RBC.

19. Explain why a Trickling Filter or RBC may be intentionally shock loaded with chlorine.

20. Describe the potential affects on biomass growth from the following shock loads:

A. Hydraulic Shock Load.
B. BOD Shock Load.
C. Toxic Shock Load.

21. Define recirculation ratios and give examples for the following types of Trickling Filters:

A. Low-Rate.
B. Intermediate.
C. High-Rate.

22. List the steps to take if an RBC unit is to be taken out of service for an extended period of time.

23. Describe how to determine if enough sludge is being removed from the clarifiers.

CONCEPT: MAINTENANCE

24. Explain what to look for when evaluating rock media in a Trickling Filter.

25. Describe the following tasks, and explain why each is important in the maintenance of Trickling Filters.

A. Cleaning nozzles and splash plates.
B. Flushing distributor arms.
C. Adjusting stay rods (guy wires).
D. Checking distributor bearings and lubrication.

26. Discuss a method and frequency of cleaning Trickling Filter underdrains.

27. Explain why clarifier weirs should be regularly brushed-down and/or washed-off.

28. List three items to inspect when performing a maintenance inspection of a secondary clarifier.

29. List the maintenance items to consider for a clarifier scraper or chain drive mechanism.

30. List the maintenance tasks to perform on the following RBC equipment:

A. Shafts and Main Bearings.
B. Drive Motor.
C. Diffusers.
D. Drive Assembly Units.
E. Blower Equipment.

31. List the key items that should be found on an RBC maintenance schedule.

32. Explain what emergency measure an operator can do if the power to an RBC unit is shut-off for an extended period of time (4 hours).

MODULE C: MONITORING AND TROUBLESHOOTING

CONCEPT: MONITORING

33. Identify the sampling locations to be used to determine BOD and suspended solids removal.

34. Identify the sampling locations for BOD or suspended solids Removal for the following:

A. WPDS Monitoring (BOD and SS) and overall plant efficiency.
B. Soluble BOD Removal from an RBC.
C. Fecal Coliform Monitoring.

35. Describe the laboratory test that best indicates the operating efficiency of a Trickling Filter or RBC.

CONCEPT: TROUBLESHOOTING

36. List three methods of reducing freezing problems of Trickling Filters.

37. Outline the possible causes and corrective actions for the following Trickling Filter problems:

A. Ponding.
B. Excessive filter flies.
C. Odor problems.
D. Icing problems on media and/or clarifier.

38. Describe the possible causes and corrective actions to be taken for the following mechanical problems with RBC units:

A. Shaft Bearings Running Hot or Failing.
B. Motors Running Hot (If Over 40^{o}C.).

39. Describe the possible causes and corrective actions to be taken for the following operational problems with RBC units:

A. Odor Problems.
B. Excess Growth On The First Stage.
C. Sudden Biomass Loss.
D. Solids Accumulation In The Reactor Tanks.

40. Describe the possible cause and corrective actions for an air-driven RBC that fails to rotate, or rotates unevenly.

MODULE D: SAFETY AND CALCULATION

CONCEPT: SAFETY

41. List the safety precautions related to the operation of Trickling Filter units.

42. List the safety precautions related to the operation of RBC units.

CONCEPT: CALCULATION

43. Given data, calculate influent loading in pounds of BOD per day/ 1000 cubic feet of media.

44. Given data, calculate pounds per day of BOD from digester super-natant or other sidestreams.

45. Given data, calculate pounds of BOD/load from one 5,000 gallon load of septic tank sludge.

46. Given data, calculate the total pounds of soluble BOD per day to the secondary treatment unit.

47. Given data, calculate the total surface area of an RBC unit(s).

48. Given data, calculate the loading to the first stage in pounds of soluble BOD per day per 1000 Ft^2.

49. Given data, calculate the loading to all RBC stages in pounds of BOD per day per 1000 Ft^2.

50. Given data, calculate the theoretical detention time in a rectangular clarifier.

ADVANCED

MODULE A: PRINCIPLE, STRUCTURE AND FUNCTION

CONCEPT: PRINCIPLE OF OPERATION

1. Describe the appearance and types of microorganism growth on the various stages of an RBC unit.

2. Describe the types of microorganism growth in a Trickling Filter.

3. Define nitrification/denitrification and how the following variables affect the process:

A. Temperature.
B. Dissolved Oxygen.
C. pH.
D. Detention Time.

CONCEPT: STRUCTURE AND FUNCTION

4. Discuss the density of RBC media at various stages of a system.

5. Compare various types of media used in a Trickling Filtration system.

6. Explain multi-stage (series) and parallel operation of Trickling Filters.

MODULE B: OPERATION AND MAINTENANCE

CONCEPT: OPERATION

7. Outline the procedure for start-up of a Trickling Filter.

8. Describe the operational problems caused by various dissolved oxygen levels in both Trickling Filters and RBC's.

9. List the organic loading of soluble BOD per 1000 square feet of media for the following:

A. For First RBC Stage.
B. For Overall RBC Train.
C. When Using High Density Media on Later RBC Stages.

10. Explain the nitrification/denitrification affects on the following:

A. Final Clarifier Operation.
B. Oxygen Demand.
C. Biochemical Oxygen Demand.
D. Effluent Quality.

11. State the normal rotational speed of an RBC, and describe how to alter the speed of the following:

A. Mechanical Drive Units.
B. Air-Driven Units.

12. Discuss what determines the normal rotational speed of a Trickling Filter distributor arm.

13. List ways an operator can control the speed of the distributor arm of a Trickling Filter.

14. Describe the term "filter channeling" in Trickling Filtration.

15. Discuss the effects that seasonal temperature changes have on the operation of a Trickling Filter or an RBC.

16. List ways to test and improve Trickling Filter ventilation.

17. List the items to consider when establishing a sludge removal schedule for a secondary clarifier.

18. Explain how to determine if secondary sludge should be pumped to a primary clarifier <u>before</u> pumping to a digester.

19. Describe the characteristics of secondary sludge from a Trickling Filter and an RBC.

20. Discuss clarifier weir overflow rates, and how they affect performance.

21. Describe the common ways of recirculating flow through a Trickling Filter for the following situations:

A. To reduce wastewater organic strength to the filter.
B. For increased hydraulic flow to increase sloughing and/or maintain flow rate over filter.
C. To reduce detention time in the primary clarifier to prevent odors during low flows.
D. To improve the dissolved oxygen level to filter effluent.

CONCEPT: MAINTENANCE

22. List the daily, weekly, monthly, quarterly, and annual activities for maintenance of a Trickling Filter.

23. List the weekly, monthly, quarterly, and annual activities for maintenance of an RBC unit.

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MODULE C: MONITORING, TROUBLESHOOTING AND CALCULATION

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CONCEPT: MONITORING

24. Compare the following for standard(low)rate, intermediate rate, and high rate Trickling Filters:

A. Hydraulic Loading Rates.
B. Organic Loading Rates.
C. Recirculation Ratios.

25. Define the following tests:

A. Carbonaceous BOD.
B. Nitrogenous BOD.
C. Inhibited BOD.
D. Soluble BOD.
E. Ultimate BOD.

26. Outline a procedure for sampling soluble BOD, and explain its significance in assessing RBC performance.

27. Explain the following procedures for testing for ammonia nitrogen:

A. Selective Electrode Method.
B. Nesslerization.
C. Titrimetric Method.

28. Describe sample sites and tests that should be run at each site to monitor a Trickling Filter plant.

CONCEPT: TROUBLESHOOTING

29. Explain the effects of the following on Trickling Filter and RBC operations.

A. Toxic Shock Loadings.
B. Organic Shock Loadings.
C. Hydraulic Shock Loadings.

30. List the affects industrial discharges may have on RBC treatment efficiency, and give corrective steps to reduce their impact.

31. List some reasons that would cause a Trickling Filter four-arm distributor not to turn.

32. Explain why an RBC plant might experience a sudden increase in chlorine residual, without increasing the chlorine feed rate.

33. Describe the possible causes and corrective actions to be taken for the following problems in a Trickling Filter:

A. Poor BOD removal efficiency.
B. Failure to meet ammonia limits.
C. Poor suspended solids removal efficiency.

34. Describe the possible causes and corrective actions to be taken for the following problems in an RBC unit:

A. White growth covering most of the first stage.
B. Failure to meet ammonia limits.
C. Excessive load weights on shafts.

35. List some reasons why a clarifier can experience a build-up of sludge, even through adequate sludge pumping time is being provided.

36. Describe the potential chain of events if secondary clarifier sludge pumping rates are consistently:

A. Too Low.
B. Too High.

37. Suggest corrective actions for the following causes of low DO in an RBC unit:

A. Influent Wastewater Causing An Organic Overload.
B. In-Plant Sidestreams Causing An Organic Overload.
C. Primary Clarifier Causing An Organic Overload.

CONCEPT: CALCULATION

38. Given data, calculate the percent removal of BOD and suspended solids from an RBC plant.

39. Given data, calculate a recirculation ratio.

40. Given data, calculate average detention time for a clarifier.

41. Given data, calculate, find maximum loading and determine how many RBC trains should be in operation.

42. Given data, calculate the feed rate of chlorine for an RBC in pounds per day.

43. Given data, calculate the surface settling rate of a circular clarifier.

44. Given flow and weir length, calculate weir overflow rate.

45. Given data, calculate the organic loading rate to a Trickling Filter.

46. Given data, calculate how much of the flow (percentage) should go to each of two Trickling Filters operating in parallel.

47. Given data, calculate the hydraulic loading in gallons per day per square foot to a Trickling Filter.

48. Given data, calculate the organic pound loading of BOD and Suspended Solids to a Trickling Filter.

49. Given data, calculate the pounds BOD per day of recirculation loading.

RESOURCES

1. CONTROLLING WASTEWATER TREATMENT PROCESSES. (1984). Cortinovis, Dan. Ridgeline Press, 1136 Orchard Road, Lafayette, CA 94549.

2. OPERATION OF MUNICIPAL WASTEWATER TREATMENT PLANTS. Manual of Practice No. 11 (MOP 11), 2nd Edition (1990), Volumes I,II,and III. Water Environment Federation (Old WPCF), 601 Wythe Street, Alexandria, VA 22314-1994. Phone (800) 666-0206.

3. OPERATION OF WASTEWATER TREATMENT PLANTS. 3rd Edition (1990), Volumes 1 and 2, Kenneth D. Kerri, California State University, 6000 J Street, Sacramento, CA 95819-6025. Phone (916) 278-6142.

4. OPERATION OF WASTEWATER TREATMENT PLANTS. Manual of Practice No.11 (MOP 11) (1976). Water Pollution Control Federation, 601 Wythe Street, Alexandria, VA 22314-1994. Phone (800) 666-0206. (Probably Out-Of-Print, See second reference above.